# Launch Vehicle

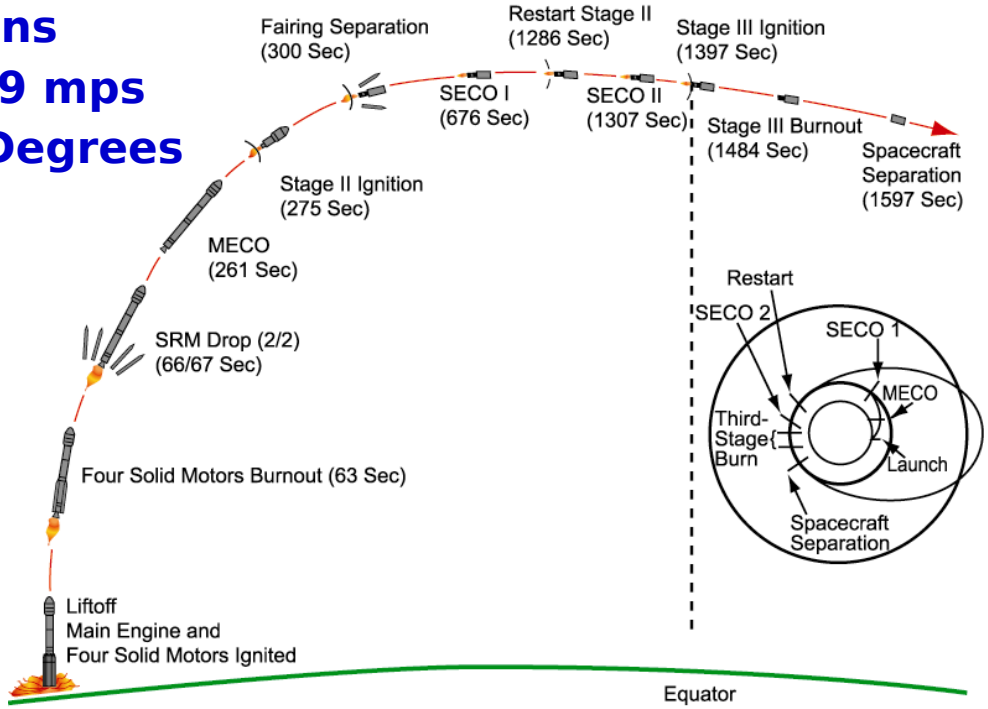
**Ron Contillo**
**Launch Vehicle Integration**
**Praxis, Inc.**
**703-837-8400**
**contillor@pxi.com**

# Current Baseline/Approach

- **Boeing Delta II 7425-10 (2425-10)**
  - **3m/10’ Dia. Composite Fairing**
  - **29.1’ in Length**
  - **1st Stage - Rocketdyne RS-27A Main Engine Along With 4 GEM Solid Rocket Strap-ons**
  - **2nd Stage - Aerojet AJ10-118K**
  - **3rd Stage - Star 48B SRM (Off-Loaded 547 lb)**

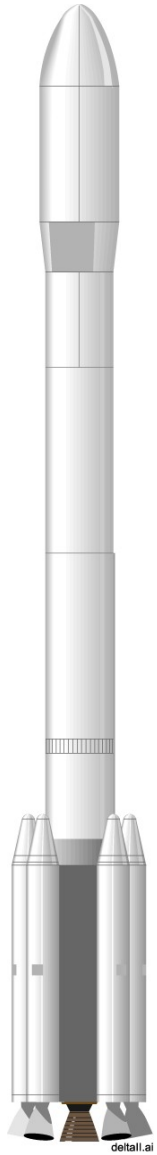
# Mission Profile and Performance Capability

- **Inclination = 28.7 Degrees**
- **Orbit = GTO Less 500km**
- **99.7% PCS, Socketrons Removed, De-Spin System Included**
- **Mass Capability = 1110 kg/2447 lb**
  - **Current FAME Mass (With Uncertainty) = 1123 kg/2476.88 lb**
  - **Mass Margin in LV = -13.0 kg/-29.88 lb**
- **3-Sigma Orbit Dispersions**
  - **Perigee Velocity = ± 9 mps**
  - **Inclination = ± 0.48 Degrees**




Eastern Range Launch Site, Flight Azimuth 95 Deg;
Maximum Capability to 28.7 - Deg Inclined GTO, 100 - nmi Perigee

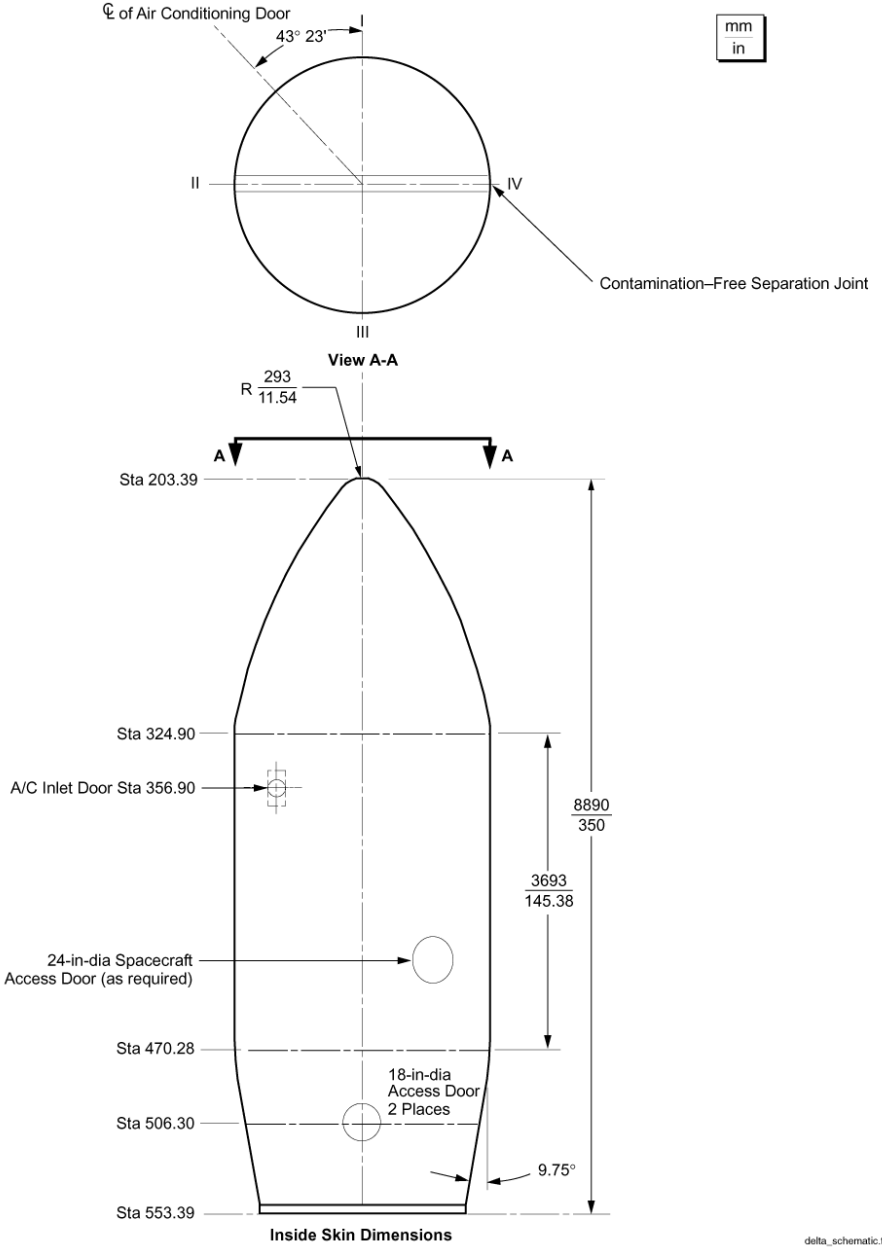
fame_msn_profile.tif



deltaII.ai

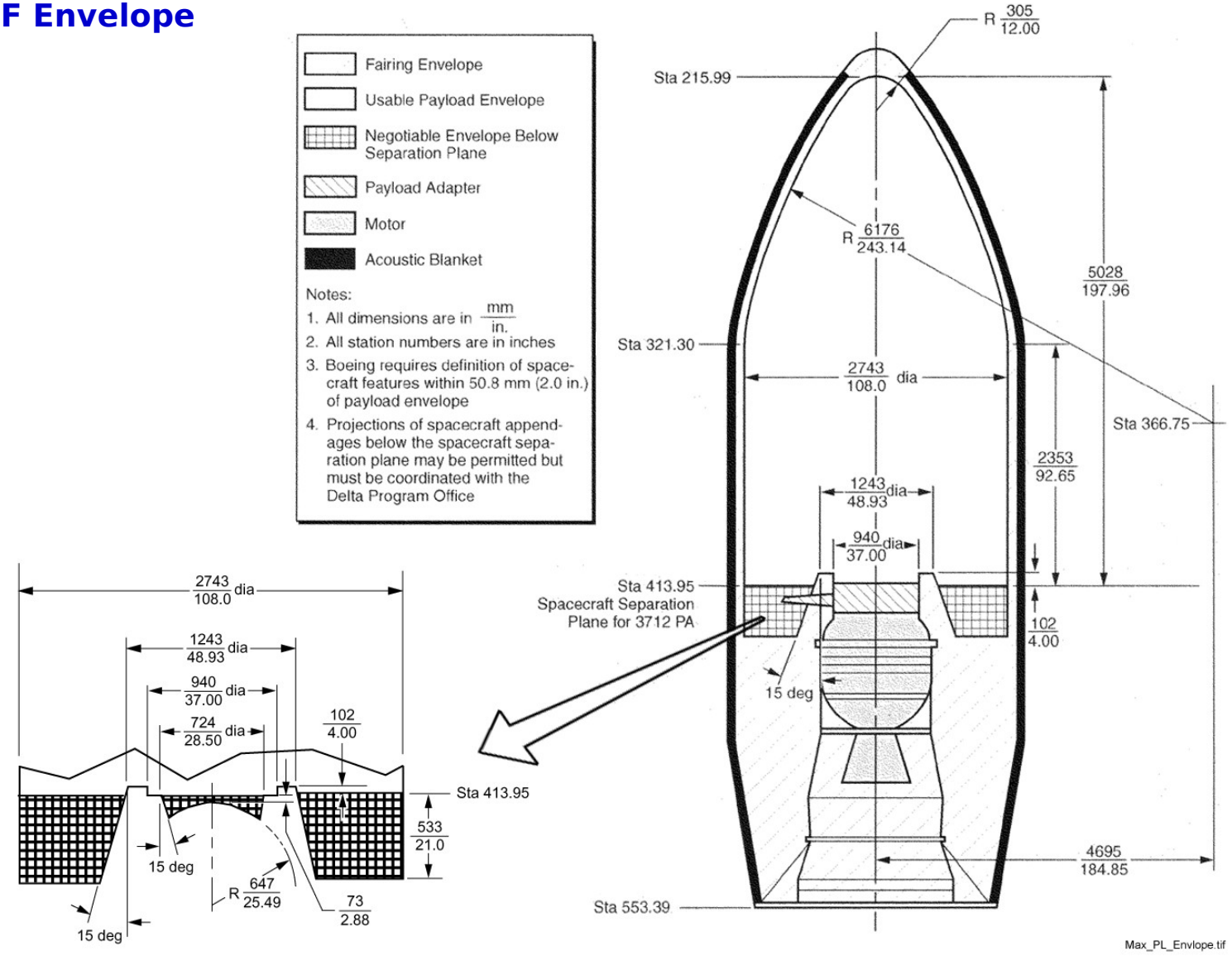
# Payload Accommodations and Major Interfaces (1 of 8)

- **3m/10’ Dia. Composite PLF**
  - **3” Acoustic Blankets From Boattail to Sta. 213.42 in Nose Section**
  - **3 Standard 24” Dia. Doors for S/C Access Part of Baseline Service**
  - **1 Standard A/C Inlet Door**

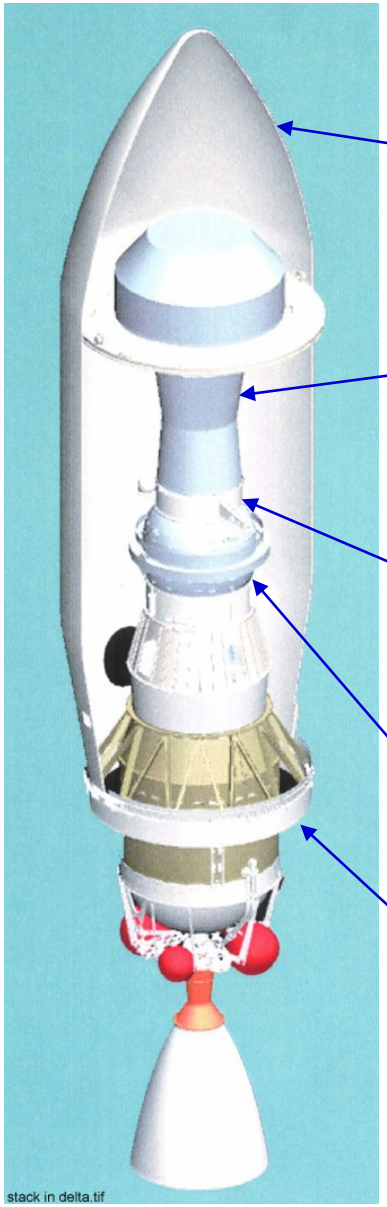


# Payload Accommodations and Major Interfaces (2 of 8)

- **10’ PLF Envelope**



# Payload Accommodations and Major Interfaces (3 of 8)




10 ft Fairing

FAME Flight Vehicle in 10 ft Fairing

3712A PAF

3rd Stage/Star 48

2nd Stage

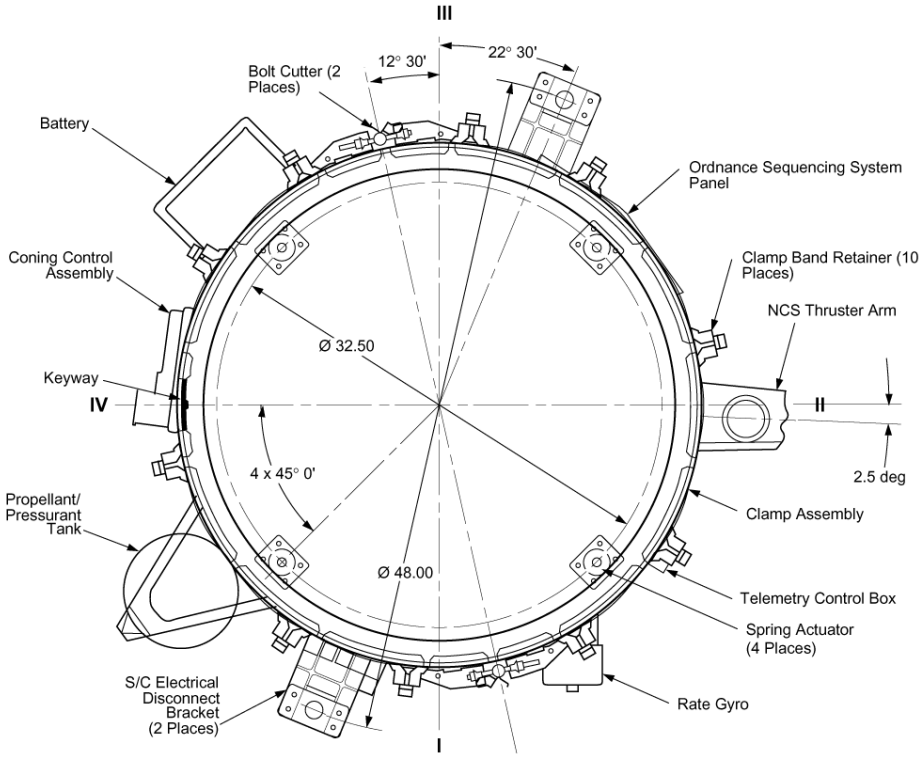
# Payload Accommodations and Major Interfaces (4 of 8)

- **3712A Payload Attach Fitting (PAF)**
  - **Maximum Clamp Assembly Flight Preload = 6800 lb**
  - **S/C PAF Flange Angle = 15 Degrees**

PAF_assy.tif

# Payload Accommodations and Major Interfaces (5 of 8)

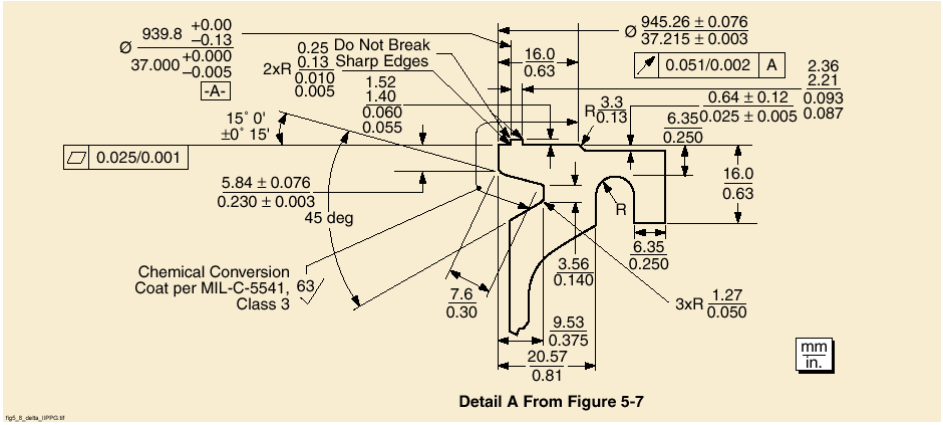
- **3712A PAF Detailed Assembly**



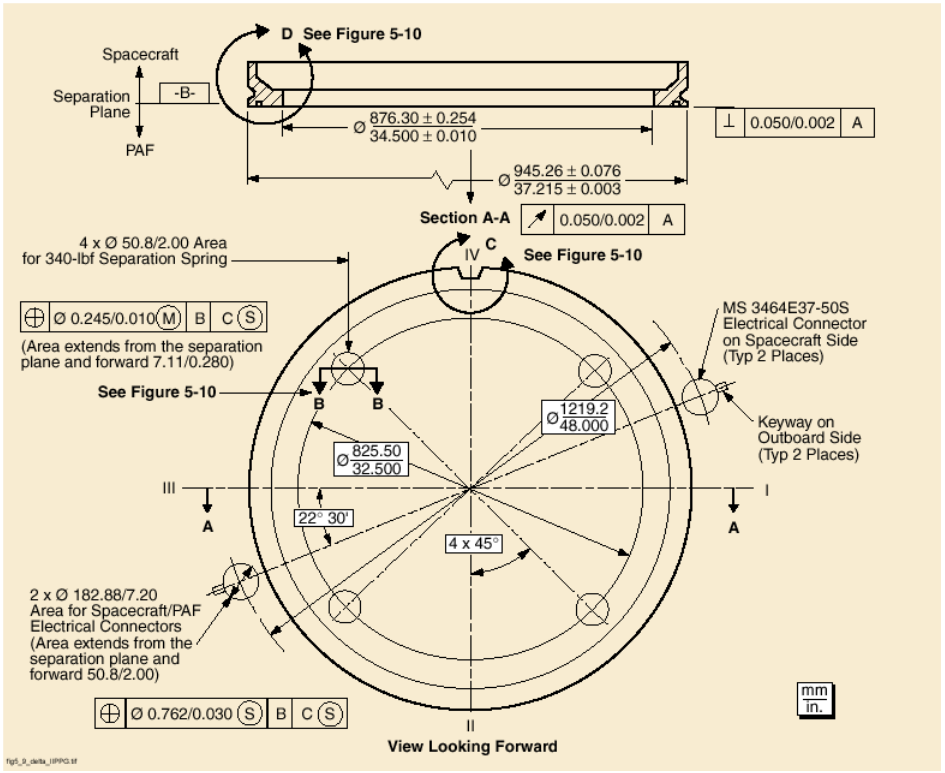

PAF.tif

# Payload Accommodations and Major Interfaces (6 of 8)

- **3712A PAF Interface Dimensions**

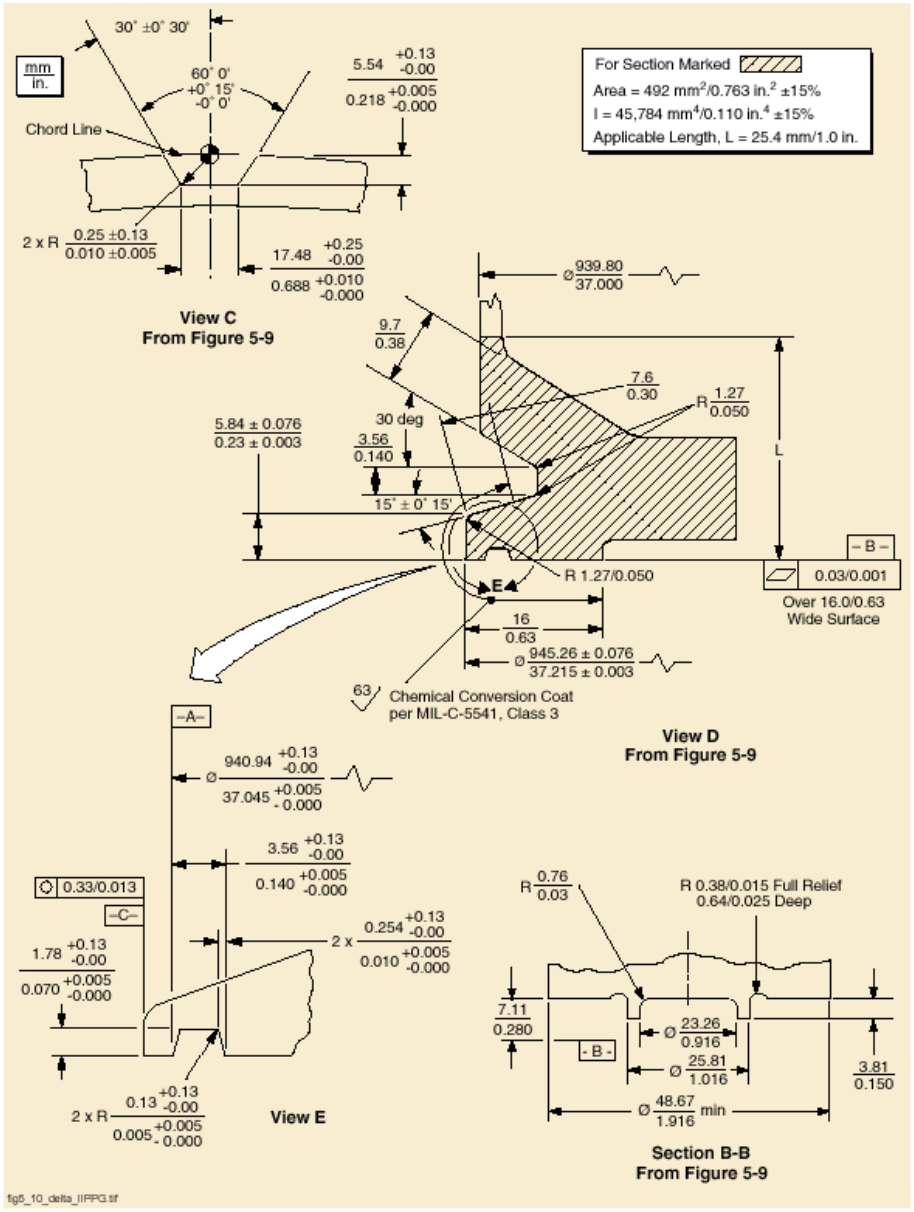



Detail A From Figure 5-7



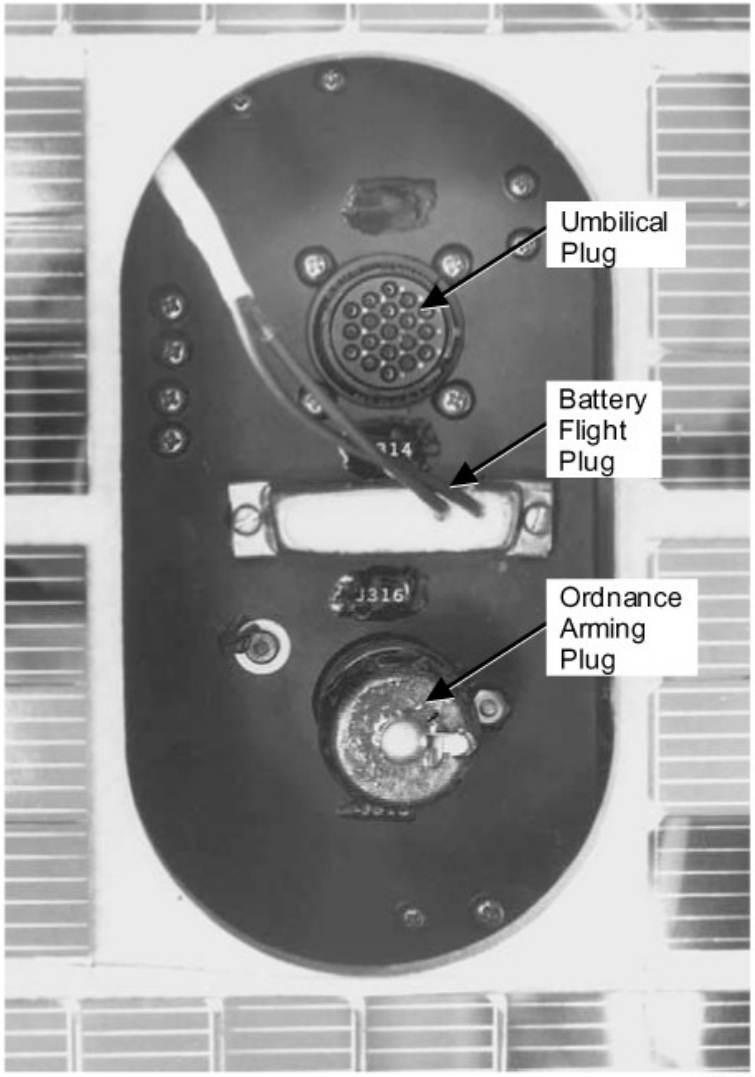

View Looking Forward

# Payload Accommodations and Major Interfaces (7 of 8)



# Payload Accommodations and Major Interfaces (8 of 8)

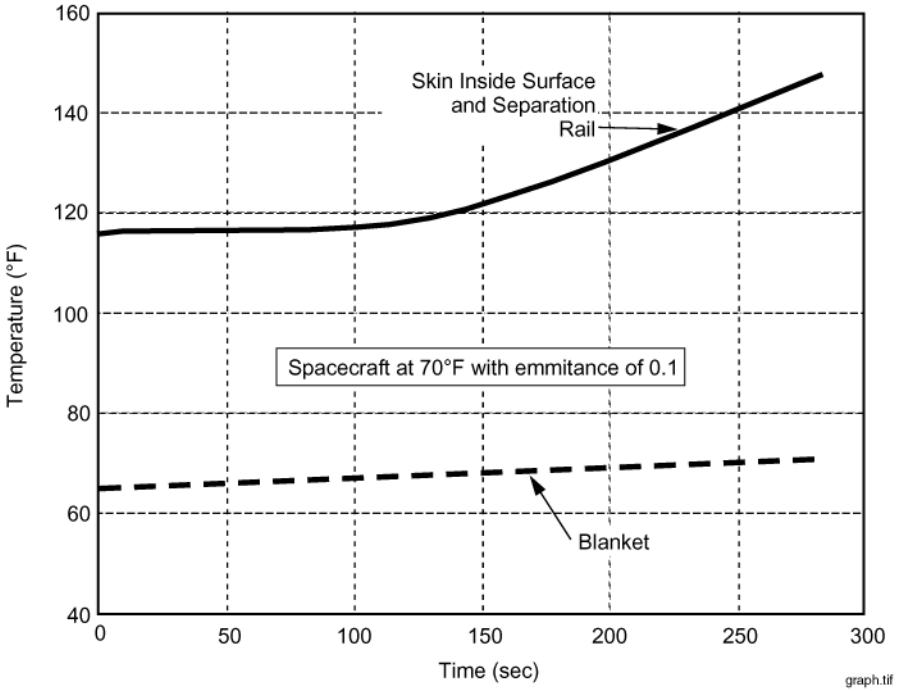
- **Electrical Interfaces**
  - **Two Standard 37-Pin S/C Umbilical Electrical Quick-Disconnect Connectors Located on PAF 180 Degrees Apart**
  - **Option for 61-Pin As Non Standard Service, If Required**
  - **Can Also Have Spacecraft Separation Switch Installed – to Be Coordinated With Delta Program Office**
  - **Standard Console and Blockhouse Provisions**



plug.tif

# Environments (1 of 5)

- **Air Conditioning/Humidity/Contamination Control:**
  - **SLC-17:**
    - **Temp = 70 +/- 5 Degrees F**
    - **Humidity = 35 - 50%**
    - **Cleanliness = Class 100,000 (FED-STD-209D)**
- **Thermal:**
  - **Fairing Jettisoned at 0.1 Btu/ft²-sec (1135 W/m²)**



# Environments (2 of 5)

- Loads

| | Liftoff/Transonic (g) | MECO (g) |
|---|---|---|
| Lateral | +/- 3.5 | +/- 0.2 |
| Axial | +2.8/-0.2 | 7.4 +/- 0.6 |

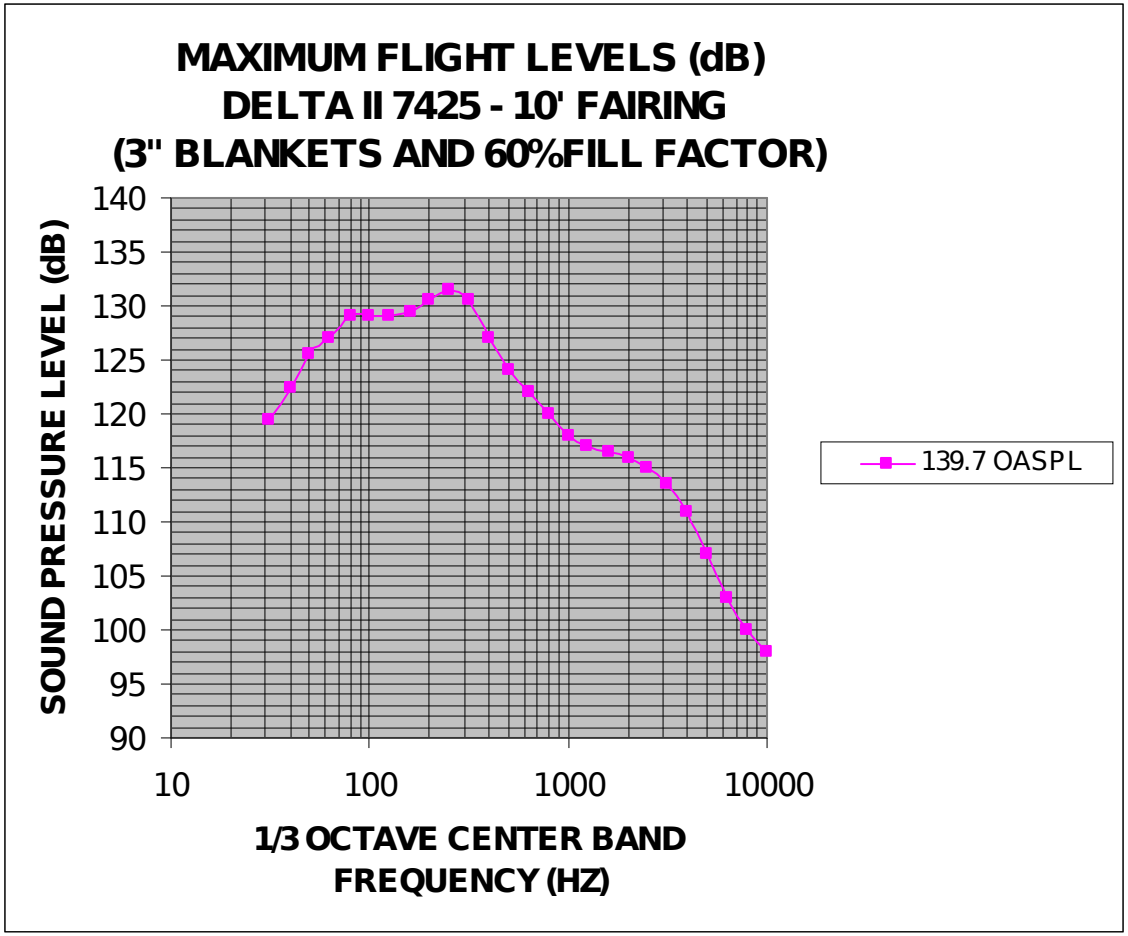
Notes:

1. Positive Axial Denotes Compression
2. Lateral Load Factor Provides Proper Bending at S/C to LV Interface
3. Assumes Fundamental Lateral Frequencies Above 20Hz and Axial Above 35Hz
4. Assumes c.g. Offset Less Than 0.8 Inches From Vehicle Centerline

# Environments (3 of 5)

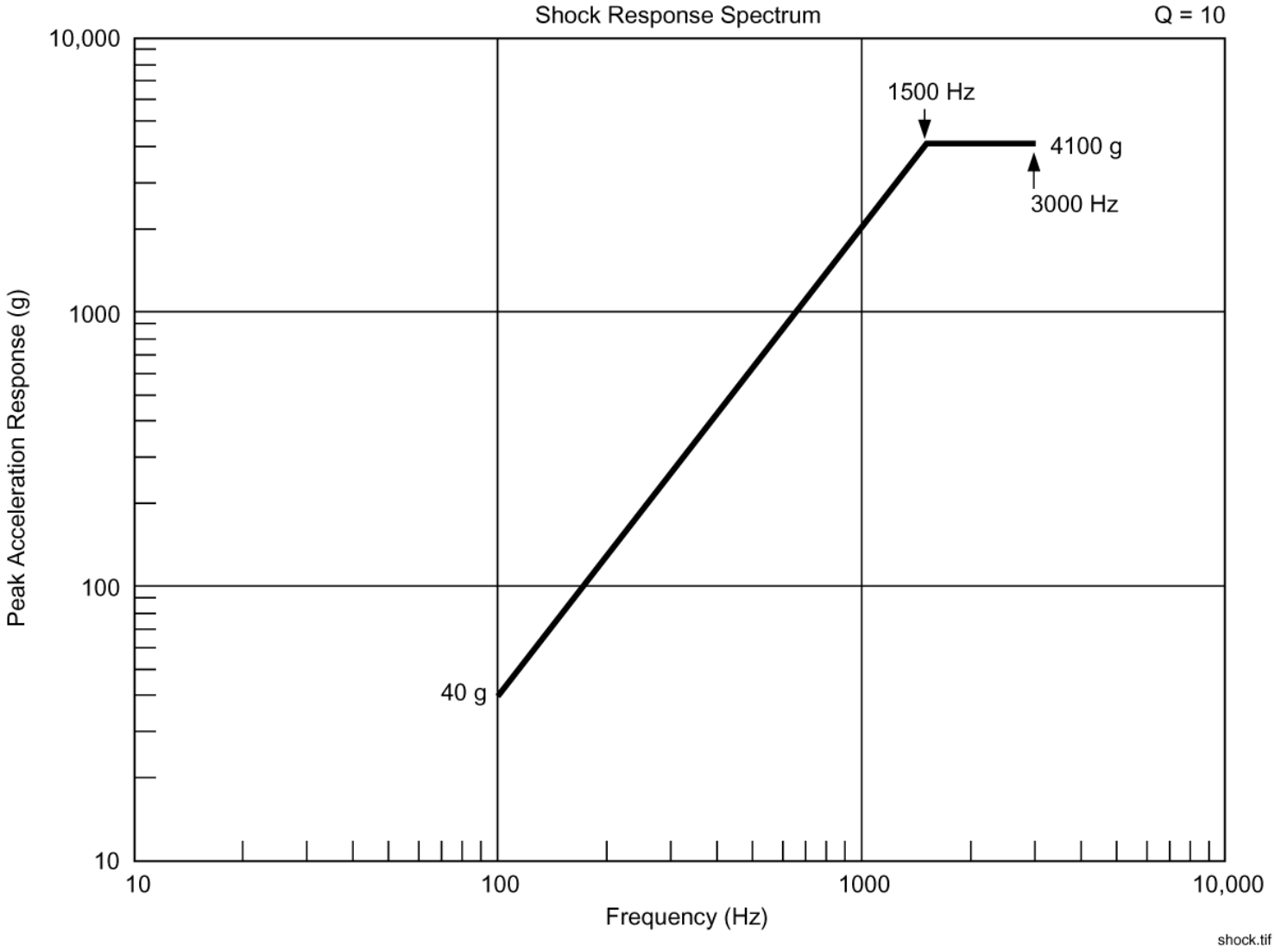
- **Acoustics:**

| Frequency (Hz) | dB Level |
|---|---|
| | |
| 31.5 | 119.5 |
| 40 | 122.5 |
| 50 | 125.5 |
| 63 | 127 |
| 80 | 129 |
| 100 | 129 |
| 125 | 129 |
| 160 | 129.5 |
| 200 | 130.5 |
| 250 | 131.5 |
| 315 | 130.5 |
| 400 | 127 |
| 500 | 124 |
| 630 | 122 |
| 800 | 120 |
| 1000 | 118 |
| 1250 | 117 |
| 1600 | 116.5 |
| 2000 | 116 |
| 2500 | 115 |
| 3150 | 113.5 |
| 4000 | 111 |
| 5000 | 107 |
| 6300 | 103 |
| 8000 | 100 |
| 10000 | 98 |



# Environments (4 of 5)

- **Shock:**



# Environments (5 of 5)

- **Sinusoidal Vibration:**

| Axis | Frequency (Hz) | Maximum flight levels |
|---|---|---|
| Axial | 5 to 6.2<br><br>6.2 to 100 | 1.27 cm (0.5 inch) double amplitude<br>1.0 g (zero to peak) |
| Lateral | 5 to 100 | 0.7 g (zero to peak) |

table.tif

# Payload Separation Attitude Accuracy and Rates

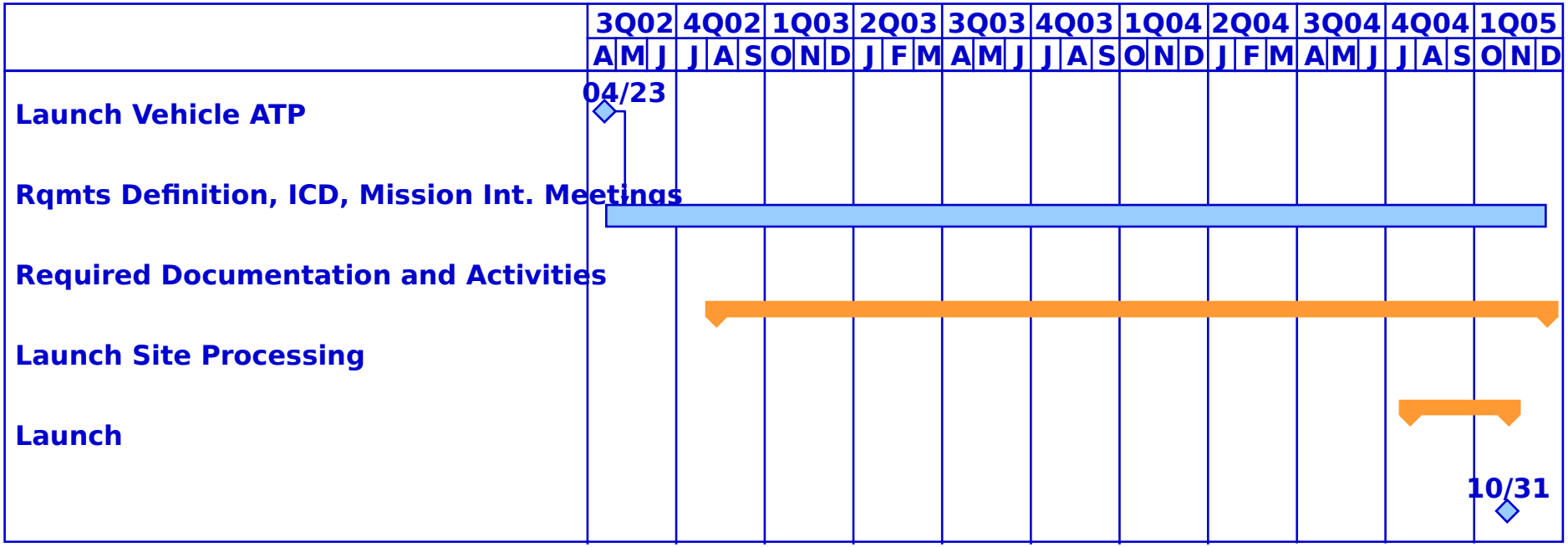
- **Standard Delta II Payload Separation Attitudes/Rates:**
  - **Spinning:**
    - **Spin Rates: up to 100 rpm (FAME Baseline 60 rpm)**
    - **De-Spin (Yo-Yo): 0 +/- 5.0 rpm (FAME Baseline 0+/-1.0 rpm)**
      - **May Require Measurement of S/C Spin MOI**
  - **Attitude: < 10.0 Degrees**
  - **Rate: < 7.0 (Transverse) dps**

***NOTE: Detailed S/C to LV Interface Requirements and Environments Can Be Found in the S/C to LV Interface Requirements Description (NCST-ICD-FM002) and later in the Boeing S/C to LV ICD***

# Integration Process

- Delta II/FAME Integration Process Is L-30 Months
- Encompasses the Entire Life of LV/Spacecraft Integration Activities
  - Requires Series of Documents, Analyses, Reports, and Working Group Meetings
  - Formal Data Exchange Between FAME, NASA-KSC, and Boeing
- Working on Initial Program Introduction With NASA-KSC
  - Mostly for System Safety Discussions, Tailoring of 127-1, etc.
  - Opportunity to Visit Facilities
- Official Kick-off/ATP in April 2002
  - Communication On-going Since Late Last Year; Initiated Weekly Telecons
    - Great Support From KSC Working Issues/Answering Questions
  - First Document Due Is Payload Questionnaire in July ’02
  - First Draft of S/C to LV Interface Requirements Description Completed – to Be Transformed by Boeing Into S/C to LV ICD
- Some of the Standard Services We Receive As Part of NASA Contract:
  - Three (3) Coupled Loads Analysis Cycles
  - Test PAF and Clampband Assembly and Boeing Engineering Support for PyroShock Tests
  - Fit Check With Flight PAF

# Launch Vehicle Schedule



# Trades Performed/ On-Going and Open Issues

- 9.5’ vs 10’ Payload Fairing
- General LV Trades:
  - 7925-10 vs 7425-10 Vehicle (Full Circle)
  - LV With No 3rd Stage (7420/7920) and FAME Providing Own 3rd Stage Capability (Combined 3rd/4th Stage)
- 3712C vs 3712A PAF
- Currently Looking at 7925-10 With Option to Solicit Secondary Payloads to Offset Additional Cost
  - Secondaries Attached to Delta II 2nd Stage
- Fairing Cleanliness
- Feasibility of 3712A PAF to Be Determined Based on High FAME c.g.
- NASA-KSC to Submit TAs to Boeing to Perform Preliminary Trajectory and Coupled Loads Analyses After Confirmation Review

# Launch Vehicle Back-Up

# 7925-10 Option

- **Increased Performance Capability (PCS 99.7%, GTO Less 500km)**
  - **1771kg/3896lb**
  - **648kg/1419lb Margin**
- **Cost Increase**
  - **$6.4M**
- **Environments**
  - **Acoustics Go Up Very Slightly (0.9 dB OASPL)**
  - **3-Sigma Orbit Dispersions a Little Smaller**